(12) **UK Patent Application** (19) **GB** (11) **2 356 735** (13) **A**

(21) Application No 0025335.1

(22) Date of Filing 03.08.1999

Date Lodged 16.10.2000

(30) Priority Data
(31) 10222003 (32) 05.08.1998 (33) JP

(62) Divided from Application No 9918310.5 under Section 15(4) of the Patents Act 1977

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(51) INT CL^7
G11B 20/18

(52) UK CL (Edition S)
G5R RB265 RB33

(56) Documents Cited
US 5237553 A

(58) Field of Search
UK CL (Edition S) G5R RB27 RB33
INT CL^7 G11B 20/12 20/18
EPODOC; JAPIO; WPI
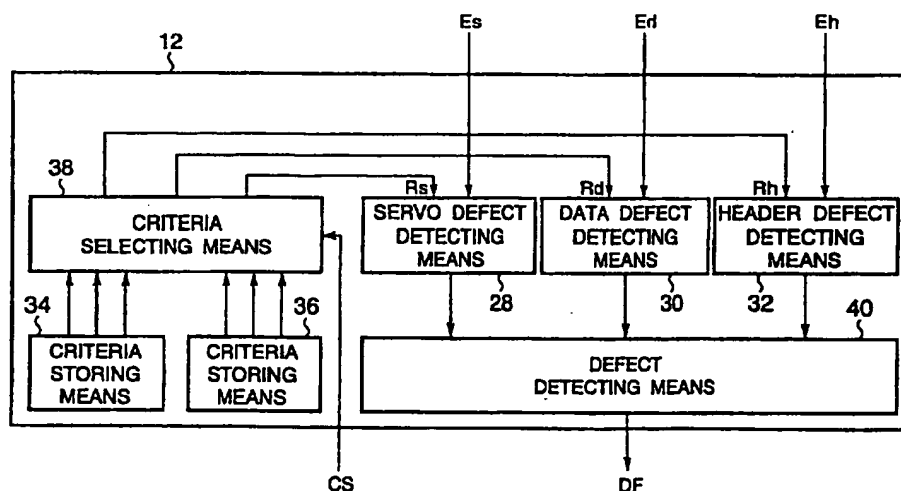
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(54) Abstract Title
Managing defects in an optical disk

(57) When optical disk defects are managed by using non-defective areas in place of defective areas, different criteria are used for detecting the defects, depending on the type of data recorded on the disk. For example, to avoid interruptions of real-time recording, less strict criteria are used when audio or video data is recorded than when computer data is recorded. The criteria themselves may also be recorded on the disk.

FIG.2

GB 2 356 735 A
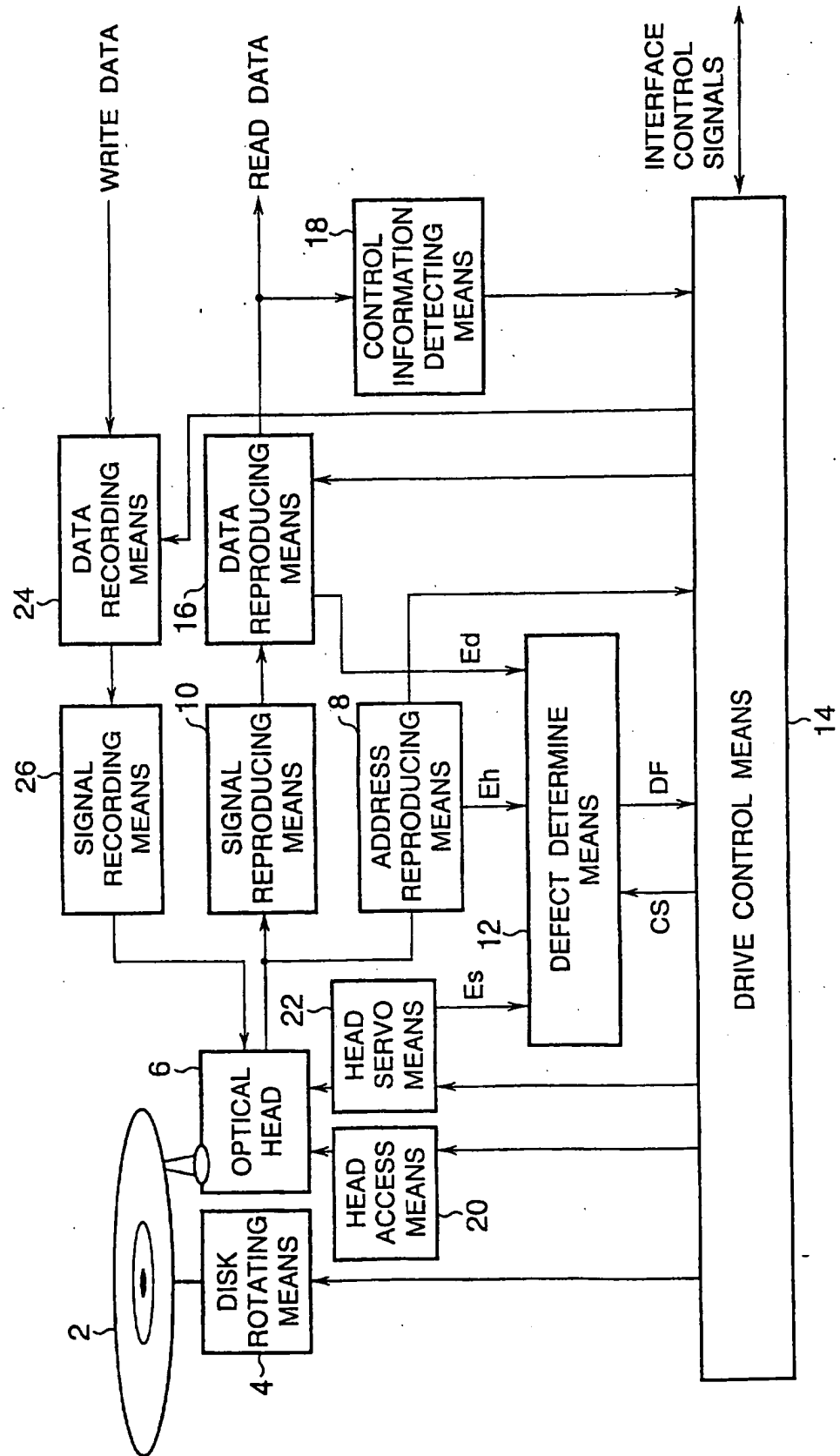
FIG.1
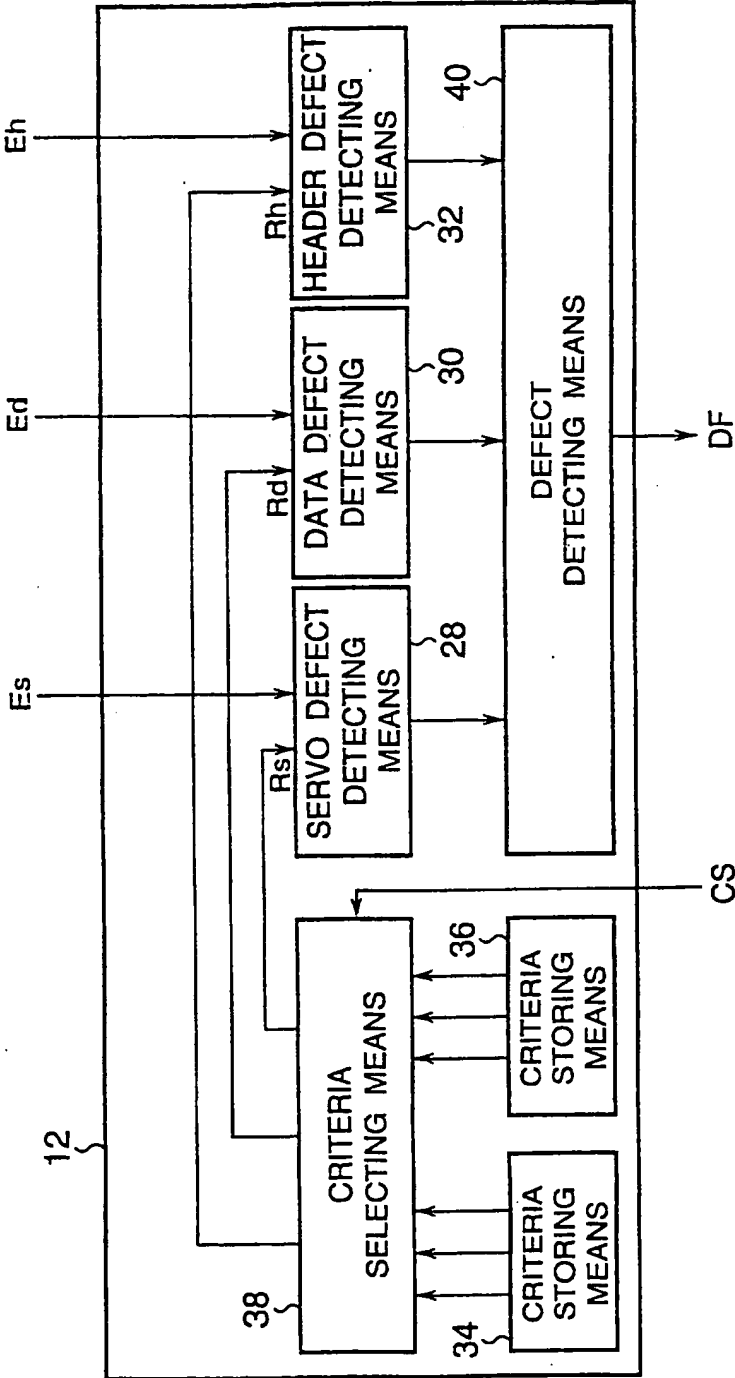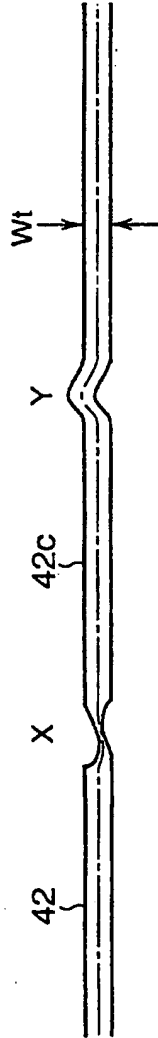
FIG.2

FIG.3A

FIG.3B

FIG.4A

1 SECTOR

HEADER AREA

DATA AREA

ID1	ID2	ID3	ID4

SYNC	CI	USER DATA + ECC	BU

FIG.4B

SIGNAL
VALUE

TIME
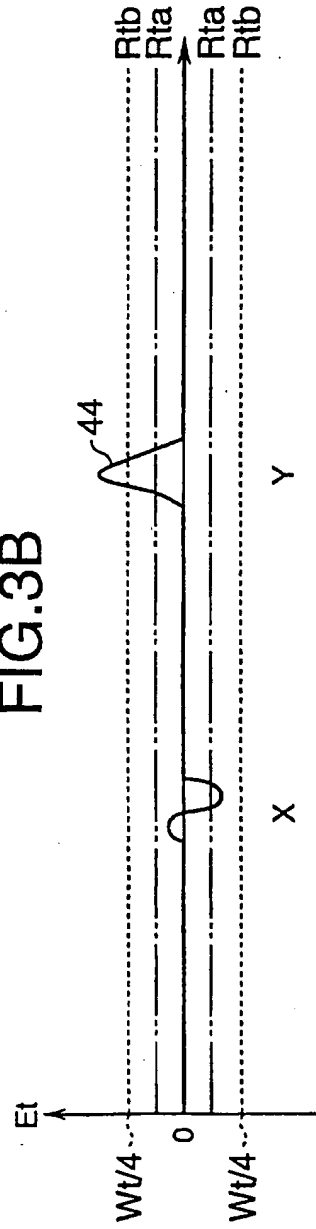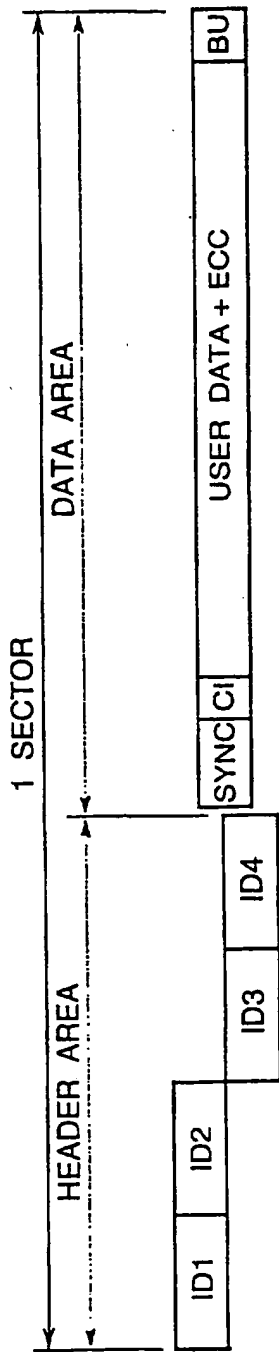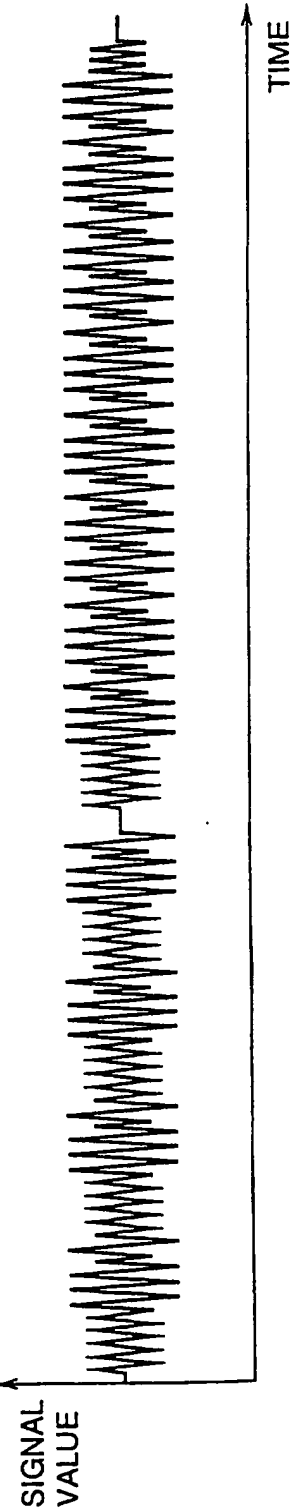
FIG.5
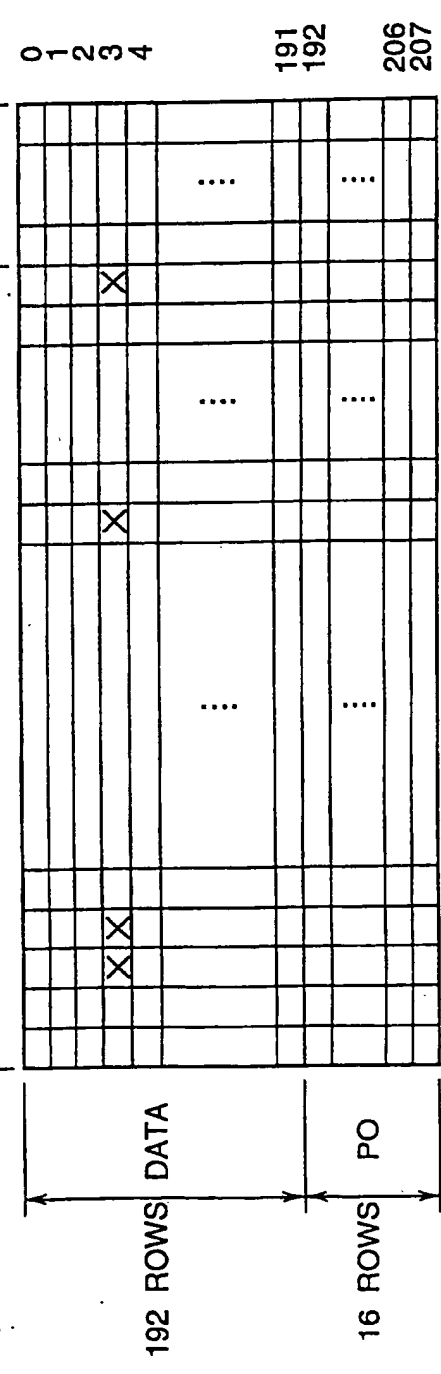
FIG.6

TYPE	CRITERIA A	CRITERIA B
SERVO DEFECT	TRACKING ERROR $\geq Wt/8$	TRACKING ERROR $\geq Wt/4$
HEADER DEFECT	AT LEAST 1 SECTOR WITH 3 OR MORE ERRONEOUS HEADERS	AT LEAST 2 SECTORS WITH 4 ERRONEOUS HEADERS EACH
DATA DEFECT	AT LEAST 8 ROWS WITH AT LEAST 4 ERRONEOUS BYTES EACH	AT LEAST 8 ROWS WITH AT LEAST 8 ERRONEOUS BYTES EACH

FIG.7

TYPE	CRITERIA A	CRITERIA C	CRITERIA B
SERVO DEFECT	TRACKING ERROR $\geq$ Wt/8	TRACKING ERROR $\geq$ Wt/6	TRACKING ERROR $\geq$ Wt/4
HEADER DEFECT	AT LEAST 1 SECTOR WITH 3 OR MORE ERRONEOUS HEADERS	AT LEAST 1 SECTOR WITH 4 ERRONEOUS HEADERS	AT LEAST 2 SECTORS WITH 4 ERRONEOUS HEADERS
DATA DEFECT	AT LEAST 8 ROWS WITH AT LEAST 4 ERRONEOUS BYTES EACH	AT LEAST 8 ROWS WITH AT LEAST 4 ERRONEOUS BYTES EACH	AT LEAST 8 ROWS WITH AT LEAST 8 ERRONEOUS BYTES EACH

FIG.8
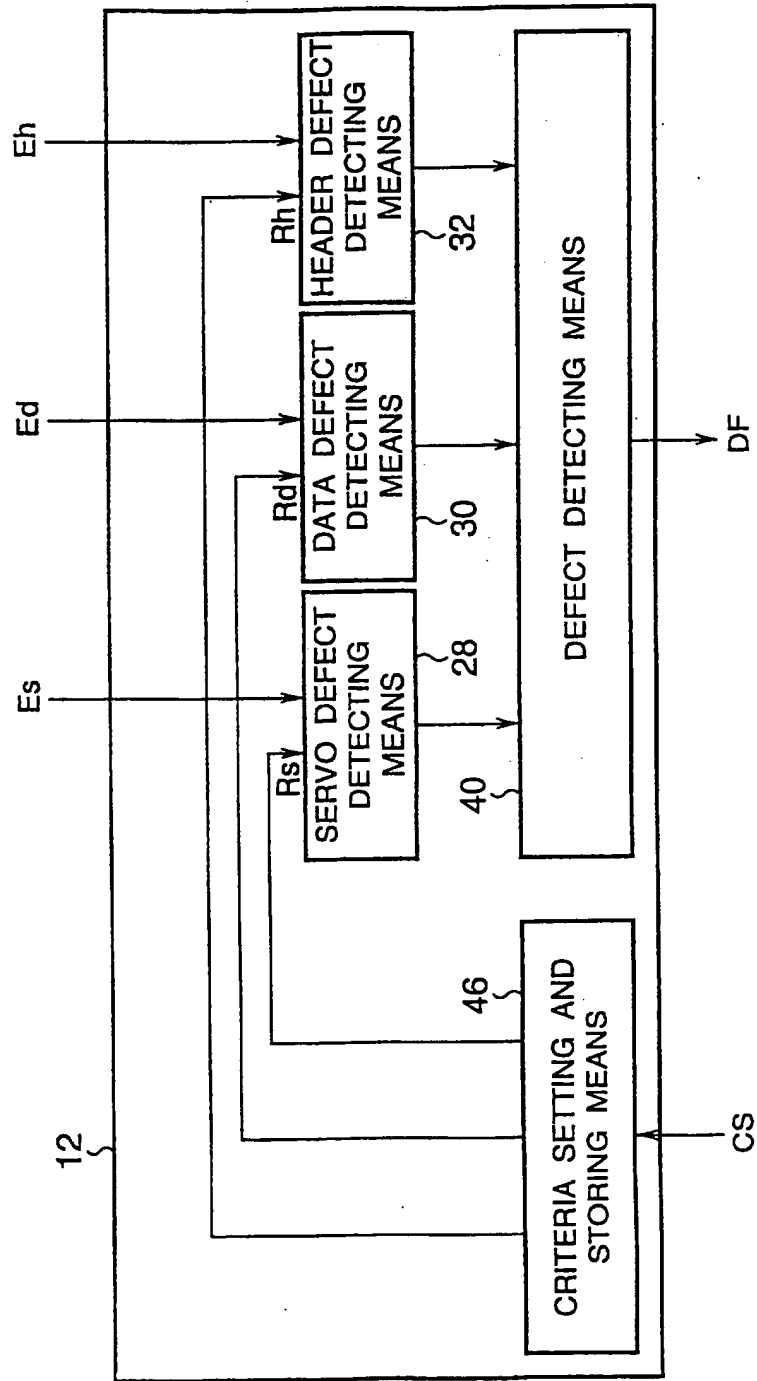
FIG.9

STEP	HOST	INTERFACE	DRIVE
1	DETERMINE APPROPRIATE CRITERIA		
2	SEND CRITERIA SETTING COMMAND	TRANSFER COMMAND (HOST→DRIVE)	RECEIVE CRITERIA SETTING COMMAND
3			STORE CRITERIA
4	PREPARE DATA		
5	SEND WRITE COMMAND	TRANSFER COMMAND AND DATA (HOST→DRIVE)	RECEIVE COMMAND AND DATA
6			RECORD DATA ON OPTICAL DISK
7	RECEIVE RESULT SIGNAL	TRANSFER RESULT SIGNAL (DRIVE→HOST)	SEND RESULT SIGNAL
8	TAKE APPROPRIATE ACTION		

FIG.10

STEP	HOST	INTERFACE	DRIVE
1	DETERMINE APPROPRIATE CRITERIA		
2	PREPARE DATA		
3	SEND COMBINED CRITERIA SETTING AND WRITE COMMAND	TRANSFER COMMAND AND DATA (HOST→DRIVE)	RECEIVE COMMAND AND DATA
4			STORE CRITERIA
5			RECORD DATA ON OPTICAL DISK
6	RECEIVE RESULT SIGNAL	TRANSFER RESULT SIGNAL (DRIVE→HOST)	SEND RESULT SIGNAL
7	TAKE APPROPRIATE ACTION		

FIG.11

b1 b0	DATA DEFECT CRITERIA
00	BLOCK: 6 DEFECTIVE ROWS ROW: 4 INCORRECT BYTES
01	BLOCK: 8 DEFECTIVE ROWS ROW: 4 INCORRECT BYTES
10	BLOCK: 8 DEFECTIVE ROWS ROW: 8 INCORRECT BYTES
11	BLOCK: 16 DEFECTIVE ROWS ROW: 8 INCORRECT BYTES

b3 b2	HEADER DEFECT CRITERIA
00	BLOCK: 1 DEFECTIVE SECTOR SECTOR: 3 ID ERRORS
01	BLOCK: 1 DEFECTIVE SECTOR SECTOR: 4 ID ERRORS
10	BLOCK: 2 DEFECTIVE SECTORS SECTOR: 3 ID ERRORS
11	BLOCK: 2 DEFECTIVE SECTORS SECTOR: 4 ID ERRORS

b7	b6	b5	b4	b3	b2	b1	b0

b5 b4	SERVO DEFECT CRITERIA
00	TRACKING ERROR $\geq$ Wt/10
01	TRACKING ERROR $\geq$ Wt/8
10	TRACKING ERROR $\geq$ Wt/6
11	TRACKING ERROR $\geq$ Wt/4

b6	APPLICABLE RANGE
0	ENTIRE DISK SURFACE
1	ONE SECTOR

b7	MODE
0	USE DEFAULT CRITERIA
1	USE SPECIFIED CRITERIA

FIG.12

CONTROL INFORMATION AREA AT INNER PERIPHERY OF DISK

DATA RECORDING REGION

CONTROL INFORMATION AREA AT OUTER PERIPHERY OF DISK

DEFECT CRITERIA INFORMATION

USER AREA

SPARE AREA

} GROUP

DEFECT CRITERIA INFORMATION
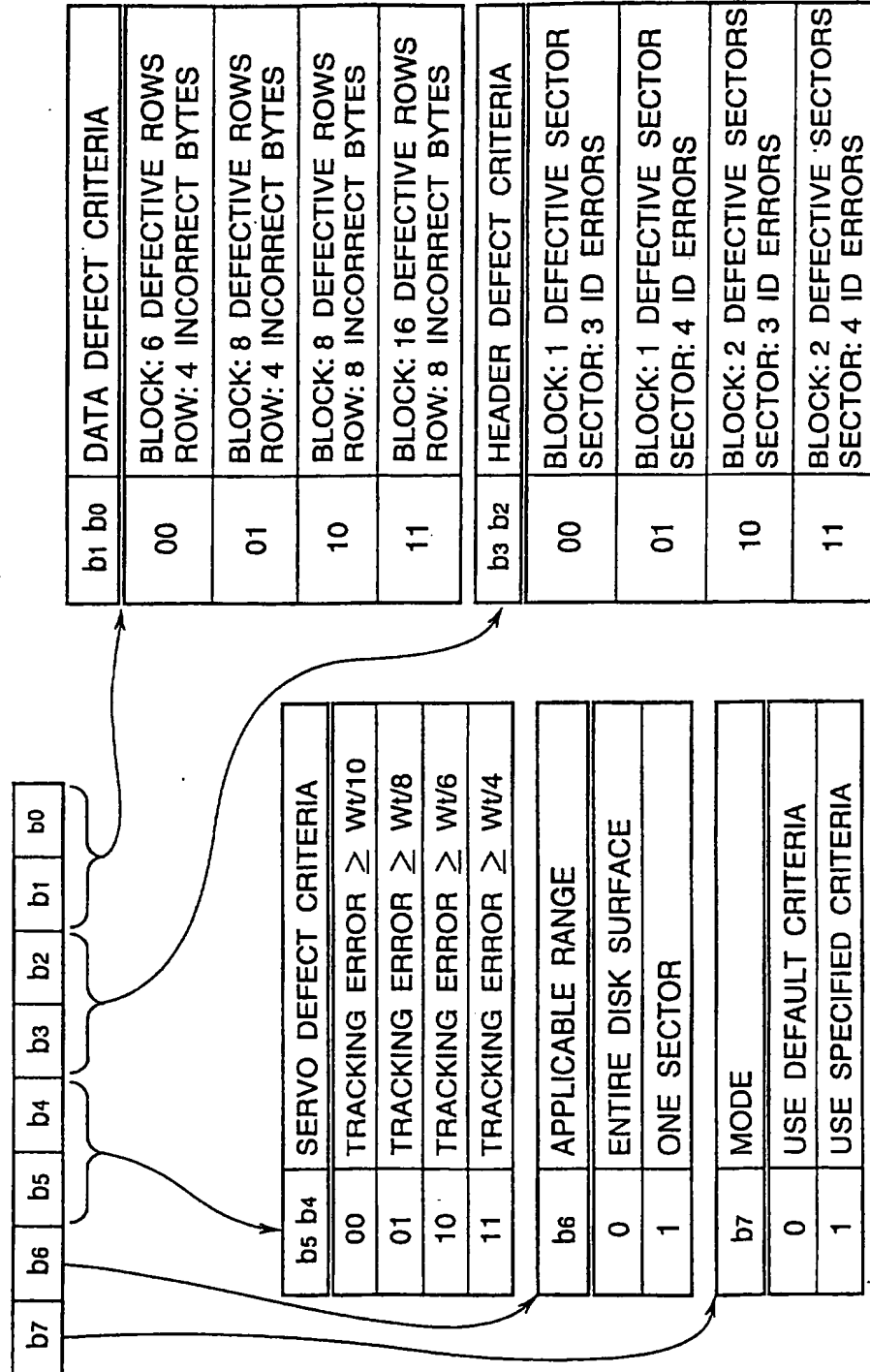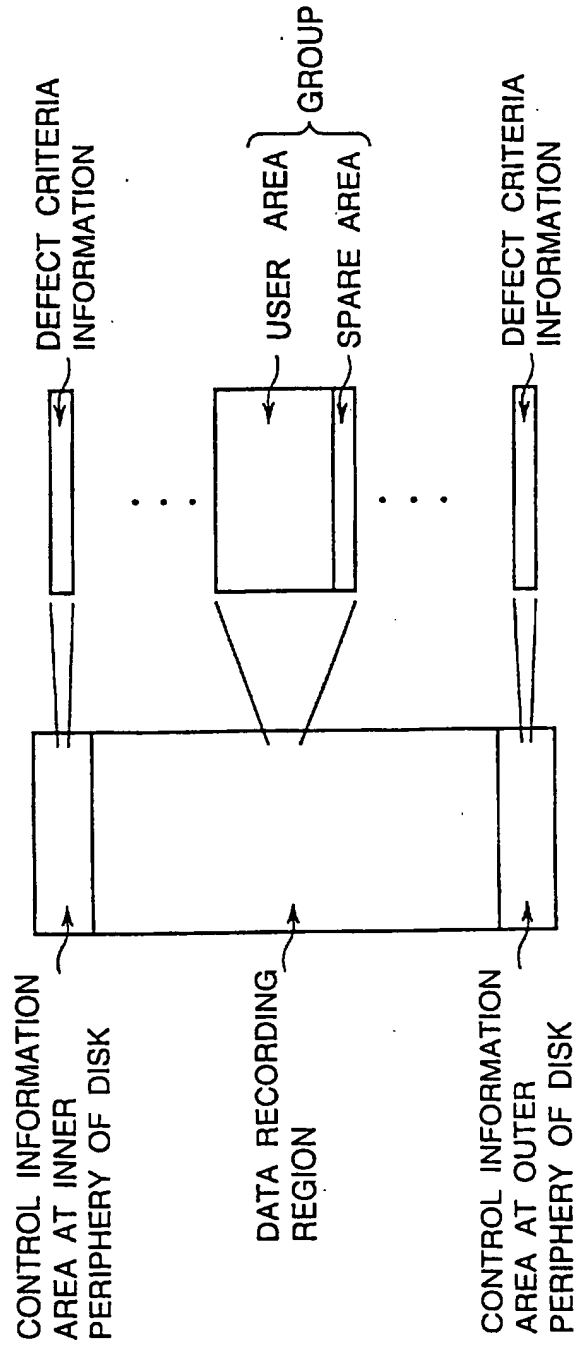
METHOD OF MANAGING DEFECTS IN AN OPTICAL DISK,
AN OPTICAL DISK DEVICE AND AN OPTICAL DISK

BACKGROUND OF THE INVENTION

The present invention relates to a method of managing
defects in a disk recording medium, an optical disk device
recording data on the optical disk using such a defect
management method, and an optical disk capable of storing
information concerning a defect criteria used for replacing
a defective area of disk with a non-defective area.

A very high degree of reliability less than 10^{-12} at
worst is required of a disk used for recording computer
data. Defect-managing systems have been used hitherto to
accommodate the reality that defects in recording sectors
which lead to an error are unavoidable, even very rare, in
the current disk-manufacturing technique.

Disk mediums are subjected to the defect management for
assuring data reliability even when dirt, scratches or
degradation due to repetition of rewriting operation is
caused. Primary defects occurring at the time of
manufacture of the disks are found through a certifying
process carried out at the time of initializing disks, and
secondary defects occurring after being put to use are found
through verification carried out at the time of writing, or
the like. Sectors found to have a defect are replaced,
using sectors located in a spare area formed on part of a
disk other than a user area. In the defect management, a
pair of a user area and a spare area is called a group.

In an example of arrangement of user areas and spare
areas on a disk, the data area consists of a single group.
However, there are many optical disks in which a data area
is divided into a plurality of groups. When a defective
group is found in a group, it is first attempted to replace
the defective sectors using sectors in a spare area of the

same group. In many cases, an optical disk is configured
such that a recording capacity of a spare area is several %
of that of a user area. The 90mm magneto-optic disk
standard defined by ECMA-154 or ECMA-201, and the DVD-RAM
standard defined by ECMA-272 are examples of such
configuration.

Incidentally ECMA is an abbreviation of European
Computer Manufacturers Association, DVD is an abbreviation
of digital video disk, and RAM is an abbreviation of random-
access memory.

The presence or absence of a defect in a sector can be
determined by an error in an ID signal representing a
physical address of the sector, an error in a recorded data
signal, or a servo error signal.

When a plurality of ID's are recorded in the header
area for each sector, if not less than a predetermined
number of ID's for each sector contain an error, the sector
in question is found have a header defect. In DVD-RAM
standard for example, each sector is provided with four
ID's, and an error can be detected for each ID. Each sector
is not found to have a header defect it has not more than
two ID errors: a sector having three or more ID errors is
found to have a header defect, since its reliability is low.

Further, the presence or absence of an error in a
recorded data signal is detected by the use of an error
correcting code added thereto. When more than a
predetermined number of errors are included per unit of
recording, the data signal is found to have a data defect.
The "unit of recording" may be a sector or a block
constituted of a plurality of sectors depending on the span
of an error correcting code (ECC).

In the DVD-RAM standard, data is recorded in sectors on
a disk, and is subjected to error-correcting coding in units
of 16 sectors, called an ECC block. Data of 32 KB

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constituting one ECC block is arranged in the form of matrix of 172 x 192 bytes (or 172 columns x 192 rows), and Reed-Solomon codes (inner code PI, outer code PO) of 10 bytes and 16 bytes are added in column direction and row direction, respectively, to constitute a product code.

The inner code PI is disposed so as to be complete within a sector. By means of the inner code PI, the number of error bytes in each row of the reproduced data can be determined. In accordance with the detected number of errors, reliability of each row is evaluated, and whether each sector or each block has a data defect can be determined based on the number. For instance, a sector including four or more rows having four or more error bytes is found to be have a data defect, or a block including six or more such rows are found to have a data defect.

With regard to detection of defects based on a servo error signal, when the magnitude of the servo error signal such as a tracking error signal exceeds a predetermined value that makes it difficult to ensure the servo control stability required of data recording, a sector in question is found to have a servo defect.

When a sector is found to have a header defect, a data defect or a servo defect, it is found to be defective.

Generally, in the defect management, two different methods are used for performing replacement of a sector. One is a slip replacement, and the other is a linear replacement.

The slip replacement is applied to primary defects. If a defective sector is found at the time of certifying a disk, the next sector is used in place of the defective sector. In a disk drive device, for accessing a sector containing data, a logical address is converted into a physical address representing the position of the sector, and a sector having ID's representing the physical address

is accessed. When the slip replacement has been performed, the physical address numbers corresponding to the logical addresses are shifted, or "slip" by one.

The slip replacement is carried out within each group. For instance, if there occur two slip replacements of m sectors and n sectors in a user area, the end of the user area of the group is shifted into the head of the spare area by (m+n) sectors. If such slip replacements are made, the linking relation between the physical addresses and logical addresses is shifted by the number of replaced sectors for all the sectors succeeding the replaced sectors. Primary defects subjected to the slip replacement are registered in a PDL (Primary Defect List). The list contains the physical addresses of defective sectors in each entry.

Linking the physical addresses with the logical addresses can be made only when a disk is initialized, and therefore, the slip replacement is applied to primary defects only.

The linear replacement is applied to secondary defects. When a defective sector is found, replacement is effected using spare sectors in a spare area. When an ECC block (formed of 16 sectors) is found to contain a defective sector, the entire ECC block is replaced with 16 sectors in a spare area. There may be a case where a block in a spare area having replaced another block is subsequently replaced with another block. A substitutive sectors are given the same logical addresses as the original sectors.

The linear replacement is effected within the same group first. For instance, when two linear replacements of m blocks and n blocks respectively occur in a user area, m blocks and n blocks at the beginning of the unused part of the spare area are used. It may be so designed that when the spare area of the same group has been used up the spare area in another group is used. Secondary defects subjected

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to linear replacement are registered in an SDL (Secondary Defect List). The list contains physical addresses of defective sectors and substitutive sectors in each entry.

When such a linear replacement has been made, every time an access is made using a logical address which designated a substitutive sector, an access to the substitutive sector and subsequent return have to be made. Therefore, the average data transfer rate is substantially lowered when the secondary defects exist.

A set of the defect lists PDL and SDL is stored in a defect management area within a control information area in each of outer and inner periphery parts. They are disposed at a plurality of locations, and they are recorded together with information on the structure of a disk.

Generally, in recording devices, criteria for detecting primary and secondary defects are set in the following way.

A disk is at its best condition when primary defects are detected and registered. The number of defects on the disk increases with time or usage due to scratches and dirt, and resultant degradation. Therefore, the primary defects are detected and replacement is effected by using a criteria which is more strict than that for detecting the secondary defects, so that some additional scratches or dirt will not results in the finding of a defect according to the criteria for detecting the secondary defects.

Although the secondary defects are detected with a criteria which is less strict than that for the primary defects, a margin of safety is left between the criteria for detecting the secondary defects and the error-correcting capability, so as to ensure error correction during reproduction. In this way, different criteria are used for the primary defect detection and the secondary defect detection.

Conventionally, optical disks are used mainly for

computer data recording, and therefore, the primary concern
was to improve the data reliability, and defect management
mainly consisting of replacement using spare sectors has
been developed to deal with the defects in the recording
sectors causing the errors.

In recent years, with increasing capacity of optical
disks, their uses are expanding to the video recording
field, such as in DVD.

Data files for recording computer data (PC files) are
expected to be completely error-free, and high reliability
is required of recording. In contrast, data files for
recording audio or video data (AV files) require recording
data inputted continuously in real time. In some cases,
errors are permissible as long as the disturbance of
reproduced images or sounds is not noticed, so that data
reliability is not required to be as high as in computer
data recording. Instead, non-interruption of recording is
important.

That is to say, with regard to storage devices for
computer data recording, primary importance is the
reliability rather than recording time, while, for storage
devices for video recording, primary importance is
continuous recording performance. Consequently, in case of
using the same type of disk for recording both audio or
video data and computer data, it is required to ensure
reliability and recording speed which meet the requirements
of the respective recordings. Likewise, defect management
is required to be adaptable to both types of recording.

Conventional defect management for optical disks has
the following drawbacks.

For carrying out replacement to deal with secondary
defects of a disk at the time of recording, data is
reproduced from the recorded part for verification, and if
errors of more than a prescribed criteria, or a defective

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part from which reproduction is impossible is found, the data recorded in that part is re-recorded in substitutive sectors in a spare area, and data is again reproduced from the substitutive sectors for verification. Thus, when a secondary defect is detected, and replacement is effected, the time needed is four times more of the time needed for recording data once. In case of recording audio or video data in real time, it is likely that recording is interrupted if a defect is detected.

One solution to this problem is not to detect secondary defects during the recording audio or video data. In this case, the reproduced image or the like may have disturbances at parts having the secondary defects, but they are considered less objectionable than interruption of recording. The underlying assumption is that once primary defects have been removed at the time of initialization of the disk, any secondary defects that might occur will be minor. If the scale of the secondary defects are beyond the prediction, the disturbance of the reproduced picture may be intolerable, and thus this solution fails.

Where the optical disks are used for recording audio or video data, it is considered unnecessary to detect defects with criteria which is as strict as that used in recording computer data. This is because, if the excessively strict criteria is used, sectors which are permissible for audio or video data are also found defective, and video recording is interrupted when the time-consuming replacement is effected. Because the conventional defect management method does not take into consideration the intended use of the optical disk, and the criteria used is of the same level regardless of the intended use of the optical disk, and there was no conception of using the optimum defect detecting method.

SUMMARY OF THE INVENTION

The present invention has been made overcome the above-outlined problem, and its object is to adapt defect management to the type of data recorded on an optical disk, or the intended use of the disk.

Another object is to improve the interchangeability of the optical disk.

A further object is to improve the utility of optical disks for recording audio or video data.

According to a first aspect of the invention, there is provided a method of managing defects on an optical disk used for recording data, comprising the steps of

determining a criteria for detecting said defects according to the type of data for which defects are to be detected; and

detecting said defects using said criteria when data is recorded on or reproduced from said disk.

With the above arrangement, it is possible to use the criteria suitable for the particular type of data for which said defects are to be detected.

Said step of detecting said defects may be performed with regard to data recorded on the disk.

In this case the defects may be detected when the data is recorded on the disk, or when the data is reproduced for verification of the data having been recorded. When the defects are detected when the data is recorded, determination of presence or absence of servo defects and header defects can be made, but determination of presence or absence of data defects cannot be made. When the defects are detected during reproduction for verification, presence of absence of data defects as well as servo defects and header defects can be determined.

Said step of detecting said defects may alternatively be performed when the data is reproduced. In such a case, if defects are detected, the reproduction of the data is re-

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tried. Decision on whether the reproduction is to be re-tried is made using different criteria depending on the type of data being reproduced.

The method may further comprise the step of using non-defective areas of the optical disk in place of defective areas of the optical disk.

With the above arrangement, the result of the defect detection can be used in making a decision as to whether the areas found to be defective should be replaced with non-defective areas.

Said step of determining a criteria may include:

providing a plurality of criteria; and

selecting one of said plurality of criteria according to the type of data for which defects are to be detected.

With the above arrangement, the defect criteria can be determined simply by providing a signal which selects one of the plurality of criteria provided in advance, rather than specifying the values forming the criteria.

Said plurality of criteria may include at least a first criteria, and a second criteria, said second criteria being less strict than said first criteria, and said step of selecting may comprise selecting said first criteria when the data for which defects are to be detected is one for which time restriction with regard to data recording or reproduction is less strict, and selecting said second criteria when the data for which defects are to be detected is one for which time restriction with regard to data recording or reproduction is more strict.

An example of the data for which time restriction with regard to data recording or reproduction is less strict is computer data. An example of the data for which time restriction with regard to data recording or reproduction is more strict is audio or video data.

By using a less strict criteria for the audio or video

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data, interruption of the audio or video data recording is avoided unless the defect is of such a degree that the resultant disturbance in the sound or picture is intorerable.

The method may further comprise the step of sending control information for specifying said criteria, from means for processing data to be recorded, to means for recording said data.

The above-mentioned means for processing data to be recorded is for example a host device. The above mentioned means for recording the data is for example a disk device.

With the above configuration, the host device can set criteria which is finely optimized for the type of the data to be recorded on the disk.

The data may be recorded in units of recording, and said step of sending control information may send the control information for each each unit of recording.

With the above configuration, it is possible to dynamically set criteria which is finely optimized for each unit of recording (e.g., sector or ECC block), depending on the type of the data to be recorded in each unit of recording. That is, even when different types of data, e.g., audio or video data, and computer data, are both recorded on the same disk, since the host device sends the criteria control information in association with the data to be recorded, and the defect management can be effected using the optimum criteria for the respective data.

Said control information specifying the criteria may select one of a plurality of criteria.

With the above configuration, the amount of control information is small, since it only needs to specify one of the plurality of predetermined criteria, rather than specifying values forming the criteria itself.

Data may be recorded in units of recording, and said

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method may further comprise the step of recording control information representing the criteria for each unit of recording, on the optical disk, in association with said each unit of recording.

With the above configuration, the criteria to be used for defect detection for each unit of recording (sector or ECC block) is known by reading the control information, and can be used for performing maintenance of the data recorded on the disk.

According to a second aspect of the invention, there is provided a disk device for accessing data on an optical disk, comprising:

means for determining a criteria for detecting said defects according to the type of data for which defects are to be recorded; and

means for detecting said defects using said criteria when data is recorded on or reproduced from said disk.

With the above arrangement, it is possible to use the criteria suitable for the particular type of data for which defects are to be recorded.

Said detecting means may detect said defects with regard to data recorded on the disk.

In this case the defects may be detected when the data is recorded on the disk, or when the data is reproduced for verification of the data having been recorded. When the defects are detected as the data is recorded, servo defects and header defects can be detected, but data defects cannot be detected. When the defects are detected during reproduction for verification, data defects as well as servo defects and header defects can be detected.

The detecting means may alternatively detect defects when the data is reproduced. In such a case, if defects are detected, the reproduction of the data is re-tried. Decision on whether the reproduction is to be re-tried is

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made using different criteria depending on the type of data being reproduced.

Said device may comprise means for managing defects on the optical disk by using non-defective areas of the optical disk in place of defective areas.

With the above arrangement, the result of the defect detection can be used in making a decision as to whether the areas found to be defective should be replaced with non-defective areas.

Said determining means may comprise:

means for storing a plurality of criteria; and

means for selecting one of said plurality of criteria according to the type of data for which defects are to be detected.

With the above arrangement, the defect criteria can be determined simply by applying a signal for selecting one of the plurality of criteria provided in advance, rather than specifying the values forming the criteria.

Said plurality of criteria may include at least a first criteria, and a second criteria, said second criteria being less strict than said first criteria, and said selecting means may select said first criteria when the data for which defects are to be detected is one for which time restriction with regard to data recording or reproduction is less strict, and selects said second criteria when the data for which defects are to be recorded is one for which time restriction with regard to data recording or reproduction is more strict.

An example of the data for which time restriction with regard to data recording or reproduction is less strict is computer data. An example of the data for which time restriction with regard to data recording or reproduction is more strict is audio or video data.

By using a less strict criteria for the audio or video

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data, interruption of the audio or video data recording is avoided unless the defect is of such a degree that the resultant sound or picture is intolerable.

Said determining means may determine the criteria according a control signal supplied from outside of the device.

The control signal may be supplied from a host device connected to the disk device.

With the above configuration, the host device can set criteria which is finely optimized for the type or contents of the data for which defects are to be detected.

The device may further comprise means for recording data, in units of recording, on the disk,

wherein

said determining means may determine the criteria for each of said units of recording, and

said recording means may also record criteria control information controlling the criteria for each unit of recording, in association with said each unit of recording.

With the above configuration, the criteria to be used for defect detection for the data of each unit of recording (e.g., sector or ECC block) is known by reading the control information, and can be used for performing maintenance of the data recorded on the disk.

According to a third aspect of the invention, there is provided an optical disk for recording data, comprising an area storing criteria control information specifying criteria to be used for detecting defects for data recorded on or reproduced from the disk.

With the above configuration, the criteria to be used for detecting defects when the disk is accessed is known by reading the criteria control information recorded on the disk. Accordingly, the maintenance of the data on the disk is facilitated, and the interchangeability of the disk is

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improved since the criteria control information can be read by any disk device.

Said data may be recorded in units of recording, and said criteria control information indicating the criteria to be used for detecting detect with regard to said each unit of recording may be recorded in association with said each unit of recording.

With the above configuration, the criteria to be used for each unit of recording, e.g., sector or ECC block, is known by reading the criteria control information, and can be used for performing maintenance of the data recorded on the disk.

Said information may select said criteria from a plurality of predetermined criteria.

With this configuration, the amount of control information is small, since it only needs to specify one of the plurality of predetermined criteria, rather than specifying values forming the criteria itself.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:-

Fig. 1 is a block diagram of an optical disk device of an embodiment of the present invention;

Fig. 2 is a block diagram of a defect determining means used in the optical disk device of Fig. 1;

Fig. 3A is a schematic diagram showing examples of deformation of a groove forming a track;

Fig. 3B is a time chart showing a tracking signal obtained when the light spot follows the track shown in Fig. 3A;

Fig. 4A is a diagram showing the configuration of a sector on a DVD-RAM;

Fig. 4B is a schematic diagram showing the signal obtained when the light spot follows the sector shown in

Fig. 4A;

Fig. 5 is a diagram showing an example of errors in an error correcting block;

Fig. 6 is a table summarizing two sets of defect criteria;

Fig. 7 is a table summarizing three sets of defect criteria;

Fig. 8 is a block diagram of a defect determining means of another embodiment;

Fig. 9 is a diagram showing an example of procedure followed for setting defect criteria;

Fig. 10 is a diagram showing another example of procedure followed for setting defect criteria;

Fig. 11 is a diagram showing the configuration of an example of defect criteria control information; and

Fig. 12 is a view showing arrangement of information for controlling defect criteria on an optical disk.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Embodiments of the invention will now be described with reference to the attached drawings, in which like parts are indicated by like reference characters.

Fig. 1 is a block diagram of an optical disk device used to implement the defect management method according to the invention. A disk rotating means 4 controls rotation of an optical disk 2 for recording and reproducing data. An optical head servo means 22 performs position control over an optical head 6 such that a light spot formed by a light beam focused by the optical head 6 follows the track on the disk 2.

The light reflected from the optical disk 2 representing the data recorded on the disk 2 is converted in the optical head 6 into an electrical signal, which is supplied to an address reproducing means 8 and a signal

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reproducing means 10. Based on an ID signal in the header, the address reproducing means 8 reproduces the address of a sector currently accessed. The detected address is sent to a drive control means 14. The signal reproducing means 10 reproduces signals from the signals supplied from the optical head 6 in accordance with the recording format. A data reproducing means 16 corrects errors in the reproduced signals to produce information, and outputs information to a host device (not shown) as reproduced data of the desired logical block.

At that moment, the data reproducing means 16 can recognize a sector in which the required data is recorded on the basis of control signals received from the drive control means 14. Concurrently, the drive control means 14 sends a command to control the rotational speed of the disk 2, to the disk rotating means 4. Further, the drive control means 14 determines the position on the disk, of the sector containing the information to be reproduced, and sends commands to the optical head access means 20 for moving the optical head 6 to the position of the sector. The drive control means 14 also sends commands to control the operation of the servo system. The optical head access means 20 and the optical head servo means 22 control the position of the optical head 6 in accordance with the received commands.

A defect management control information detecting means 18 reads control information necessary for performing defect management, from the reproduced data, and obtains information concerning defect management such as defect management method applied to the disk, arrangement of spare areas and user areas, status of use of substitutive sectors, and defect criteria. The information thus obtained is sent to the drive control means 14 and used for controlling devices engaged in defect management at the time of

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recording or reproducing data.

Incidentally, all the sectors on the disk are numbered with consecutive addresses from the inner or outer periphery of the disk. However, the addresses of user data recording sectors are not consecutive. This is because the physical addresses are assigned not only to the user data recording sectors, but also to sectors in spare areas provided for defect replacement and sectors in guard areas at zone boundaries in the case of a zone format disk.

At the time of performing access from the host device through an interface, logical block numbers of a file system are used. Therefore, the disk device needs to perform conversion between a logical block number and a sector address. The conversion is carried out by the drive control means 14 in accordance with received information on defect management.

In writing operation, data sent from the host device is first inputted to a data recording means 24. The data recording means 24 performs error correction coding on the data in accordance with a format, and outputs the data as signals to be recorded, with timings controlled in accordance with the sector addresses on the disk, having been detected by the control signals supplied from the drive control means 14.

A signal recording means 26 modulates the received signals in accordance with a recording format and sends them to the optical head 6.

The optical head 6 writes the signals into the optical disk 2 by driving a laser.

At this moment, the optical head 6 is controlled such that a light spot traces the sector the data is to be recorded, by means of the optical head access means 20 and the optical head servo means 22.

The drive control means 14 stores defect management

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control information detected by the defect management control information detecting means 18 at the time of disk loading. The logical block number of the block to be accessed is given by an interface control signal supplied from the host device, not shown. To be more specific, the host device sends a recording command specifying the logical block number of the block where the data is to be written, and the like, to the disk device, together with the data to be recorded, or sends a reproducing command specifying the logical block number of the block from which the data is to be read and the like, to the disk device.

The drive control means 14 converts the logical block number of the block to be accessed, to physical addresses, using defect management information, and sends a command specifying the physical addresses of the sectors to be accessed, to the optical head access means 20 and data recording means 24 or data reproducing means 16. The physical addresses of the sectors currently accessed are reproduced by the address reproducing means 8, and inputted to the drive control means 14. Drive control operations such as control over the optical head access means 20 and data recording means 24 or data reproducing means 16 are performed on the basis of the detected current address and the target address.

A defect determining means 12 makes judgment as to whether a sector is defective and is to be replaced. The defect determining means 12 receives information necessary for defect determination on each sector from the optical head servo means 22, address reproducing means 8, and data reproducing means 16, and determines presence or absence of a defect in accordance with a defect criteria set by the drive control means 14, and reports the results of the determination to the drive control means 14. When the sector having been accessed is determined as a defective

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sector, the drive control means 14 performs the necessary processes. During recording, the drive control means 14 interrupts the recording operation and causes the data of the block to be re-recorded in substitutive sectors. During verifying reproduction, the drive control means 14 causes the data of the block having been recorded, to be re-recorded in substitutive sectors. During reproduction, the drive control means 14 causes the reproduction to be re-tried. These operations are pre-programmed into the drive control means 14.

Fig. 2 shows the configuration of the defect determining means 12. It receives servo error signals such as a tracking error signal and a focus error signal from the optical head servo means 22. It also receives a header error signal representing the number of errors in ID's reproduced for each sector, from the address reproducing means 8. It also receives a data error signal representing the number of errors in the reproduced data from the data reproducing means 16.

In this embodiment, the defect determining means 12 includes two defect criteria storing means 34 and 36 for storing different defect criteria A and B, respectively. The two defect criteria A and B are inputted to a defect criteria selecting means 38, which selects and outputs either one of the two criteria A and B in accordance with a defect criteria setting signal CS. There are three outputs, Rs, Rd, and Rh. A reference signal Rs for detecting a servo defect is inputted to a servo defect detecting means 28, a reference signal Rh for detecting a header defect is inputted to a header defect detecting means 32, and a reference signal Rd for detecting a data defect is inputted to a data defect detecting means 30. They are compared with a servo error signal Es, a header error signal Eh, and a - data error signal Ed in the respective defect detecting

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means 28, 32 and 30, to detect presence or absence of a servo defect, a header defect, and a data defect. A defect detecting means 40 receives the outputs of the defect detecting means 28, 32 and 30, and outputs a defect detection signal DF when at least one of the defects has been detected.

Referring to Fig. 3A and Fig. 3B, detection of a servo defect will be described. For recording data, a track which has a substantially uniform width Wt (the track is actually circular or spiral, but the short part of the track illustrated can be treated as straight) is used. The track is formed of a continuous guide groove or the like. Consideration will be given to the case where the track is deformed at points X and Y. Such deformation may be caused due to dirt introduced during fabrication of a master disk or a substrate, irregular operation of a manufacturing machine, unevenness of a formed substrate, and other minor irregularities. Tracking control is performed such that a light spot follows the centerline 42c of the track shown by a chain line in Fig. 3A, and a tracking error signal Et shown in Fig. 3B is obtained. The tracking error signal Et is zero when the light spot is following the centerline 42c of the track. When the light spot deviates from the centerline 42c, the tracking error signal Et deflects either positively or negatively depending on the direction and the amount of deviation. Where there is a deformation of the track and the centerline 42c of the track is bent abruptly, since the light spot cannot follow the abrupt bending, the light spot deviates from the centerline 42c.

At point X, there is a deflection in the tracking error signal Et due to the deformation of the track. At point Y, there is also a deflection in the tracking error signal Et due to meander of the track. If the tracking error tolerance limit Rtb shown by the broken line in Fig. 3B is

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given as a reference for determining a servo defect, a servo defect is recognized at point Y. If a more strict tracking error tolerance limit Rta shown by the chain line in the figure is given, servo defects are recognized both at points X and Y.

The tracking error tolerance limit Rta corresponds to the value of the tracking signal Et when the deviation of the light spot is one-fourth the tracking width Wt, and the tracking error tolerance limit Rtb corresponds to the value of the tracking signal Et when the deviation of the light spot is one-eighth the tracking width Wt.

For instance, if the level Rta at the chain line is used as the defect criteria A, and the level Rtb at the broken line the figure is given as the defect criteria B, it is possible to perform servo defect determining process at two different levels. Incidentally, the recording track may not be a continuous groove. In a disk, such as a DVD-RAM, where user data recording areas are formed of lands and grooves, and no groove is formed at the header parts, which are formed of pre-pits only, it is sufficient to perform a servo defect detection only for areas where a groove continues.

Servo defect detection can be performed with regard to a focus error signal, in the same way as the tracking error signal.

Fig. 4A shows the configuration of a sector in a groove track in a DVD-RAM, and Fig. 4B shows the waveform of the signal reproduced from the sector shown in Fig. 4A. These drawings will be used for describing the detection of header defect. A recording sector of a DVD-RAM includes a header area having a sector address and the like at the beginning, followed by a data area for recording user data. The header area includes four ID's, indicated as ID1 to ID4 each containing address information representing a sector

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address. In the sector shown in Fig. 4A, ID1 and ID2 are displaced one-half the track width Wt toward the outer periphery of the disk, and are shared with a sector in the outer adjacent land track, while ID3 and ID4 are displaced one-half the track width Wt toward the inner periphery of the disk, and are shared with a sector in the inner adjacent land track.

In a land track not shown, ID1 and ID2 are displaced by one-half the track width Wt toward the inner periphery of the disk, and are shared with a sector in the inner adjacent groove track, and ID3 and ID4 are displaced by one-half the track width Wt toward the outer periphery of the disk, and are shared with a sector in the outer adjacent groove track. The waveform of the signal reproduced from the header area and the data area in a sector in a land track is also shown in Fig. 4B.

The data area following the header is in a groove or a land, and contains a synchronous signal (SYNC), control information (CI), user data, and an error-correcting codes, and a buffer, which are recorded successively in this order. The control information CI consists of a small amount of information (such as the data number of the sector), other than user data.

The size of user data, together with the control information, in one sector is 2 KB (kilobytes), and error-correcting coding is performed taking the user data and the control information of 32 KB in 16 successive sectors, as a unit, wherein error-correcting codes are added to the to form an ECC block.

The error-correcting codes are distributed over the 16 sectors.

The sector address can be obtained if even one of the four ID's in a header is read correctly. In criteria B, if none of the four ID's is read correctly, the sector is found

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have a header defect, and if two or more sectors within an ECC block are found to have a header defect, the ECC block is found to have a header defect. In criteria A, if not more than one of the four ID's is read correctly, the sector is found have a header defect, and if one or more sectors within an ECC block are found to have a header defect, the ECC block is found to have a header defect.

A sector found to be non-defective according to criteria A has at least two correctly readable ID's. This make it more likely that at least one ID will remain correctly readable even if the disk is later soiled or degraded, or transferred to another disk device.

In this way, it is possible to perform header defect determination with two different levels.

Fig. 5 shows the structure of an ECC block in a DVD-RAM. This drawing is used to describe the data defect detection. In the data recording means 24, the 23 KB data for 16 sectors are arranged in the form of matrix of 172 bytes in the row direction by 192 bytes in the column direction. A 16-byte parity outer code PO in the column direction is added to each column, and then 10-byte parity inner code PI in the row direction is added to each row.

Thus, a product code, which is a Reed-Solomon code, of 182 bytes x 208 bytes is formed.

When the data is recorded on the optical disk 2, the PO rows are interleaved with the other rows so that the error-correcting code bytes are evenly distributed over all 16 sectors of the ECC block.

At the time of reproduction, the data reproducing means 16 rearranges the reproduced signal into a matrix of 182 bytes x 208 bytes, and first detect and correct any errors of each row by means of the 10-byte inner code PI. The inner code PI is capable of correcting errors in up to five bytes per row, and detecting errors in up to ten bytes per

row.

Next the 16-byte outer code PO is used to detect and
correct any remaining errors. The outer code PO is capable
of correcting errors in up to 8 bytes per column, and
detecting errors in up to 16 bytes per column. These error
detecting and correcting capabilities can be improved by
repeating the PI-PO error correction process, although the
additional repetitions require additional circuitry and
additional time.

When a large number of errors are detected and
corrected, it becomes likely that some of the corrections
are wrong, the corrected data differing from the original
data. Criteria A and B are therefore set, for example, as
follows. In criteria A, a row is considered to have a data
defect if errors are detected in at least four bytes, which
is close to the error-correcting limit of the PI code, and
an ECC block is considered to have a data defect if it has
at least eight rows having a data defect. In less strict
criteria B, a row is considered to have a data defect if
errors are detected in at least eight bytes, which is close
to the repeated error-correcting limit of the PI code, and
an ECC block is considered defective if it has at least
eight rows having a data defect. When an ECC block is
considered to have a data defect, all sixteen of its
constituent sectors are replaced.

In this way, it is possible to perform data defect
determination with two different levels.

In FIG. 5, row three has errors in four bytes,
indicated by x's. This row is deemed to have a data defect
under criteria A, but not under criteria B.

In this way, the presence or absence of defect in each
sector can be determined with respect to each of the servo -
defect, the header defect, and the data defect, according to
the defect criteria supplied to each defect detecting means.

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Fig. 6 summarizes the defect criteria A and B described above described as examples for the respective defects. The set of criteria A are stored in the criteria storing means 34, while the set of criteria B are stored in the criteria storing means 36. It is then possible to switch between the two levels of criteria A and B by means of the criteria selecting means 38, according to the criteria setting signal CS.

In the case of recording computer data, a high reliability is required so that the data once recorded are not lost or changed. For this reason, verifying reproduction is often effected at the time of recording. Accordingly,
during recording and during verification production, the strict criteria A is applied to ensure that the correct data is recorded.

In contrast, in the case of audio or video data, continuous recording at a high transfer rate is required. Accordingly, verifying reproduction is often omitted, ignoring data defects. Even if some defects occur during recording, as long as occurrence of the defects is of such a degree that the defects can be corrected or concealed later at the time of reproduction, it is preferable to continue recording operation ignoring the defects, since it will improve the performance and the operability as a recorder. For this reason, the criteria set for servo defects and header defects are set at a less strict level at which the recorded data can be corrected or concealed.

When the two different defect criteria A and B available, the strict criteria A is used for recording computer data, while the less strict criteria B is used for recording audio or video data.

There are situations where more than two different levels of reliability are required depending on types of

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data to be recorded. For instance, there is a situation where three different levels are required, one for recording computer data, another for recording important audio or video data, and the last one for recording normal audio or video data. In such a situation, as shown in Fig. 7, provision is made to enable switching among three different defect criteria A, B, and C. Criteria A and B are the same as those described with reference to Fig. 6, and are used for recording computer data and for recording normal audio or video data, respectively.

The criteria C is used for recording important audio or video data, and therefore, it has strictness intermediate between the criteria A and B. In the criteria C, the allowable deviation in tracking error is one-sixth the track width Wt, and an ECC block is found to have a header defect if all four ID's are unreadable in any one sector. Regarding data defects, criteria C and A are the same.

To use the three different sets of defect criteria, the defect determining means 12 should have an additional criteria storing means, in addition to the members shown in Fig. 2, and the criteria selecting means 38 should be able to select among the criteria A, B and C supplied from the above-mentioned additional criteria storing means, as well as the criteria storing means 34 and 36 in Fig. 2, in accordance with the criteria setting signal CS.

Fig. 8 shows another embodiment of the defect determining means 12. The configuration of Fig. 8 is different from the configuration of Fig. 2 in that the criteria storing means 34 and 36, and the criteria selecting means 38 which makes selection according to the criteria selecting signal CS shown in Fig. 2 are replaced with a defect setting and storing means 46 which makes setting according to the criteria selecting signal CS.

The defect criteria to be applied is supplied from a

host device (not shown) through an interface to the drive control means 14. In response, the drive control means 14 generates a criteria setting signal CS specifying the criteria.

In the defect determining means 12 of Fig. 2, the defect criteria stored in the respective criteria storing means are fixed. However, in practical use, it may be desirable that the host device which controls the disk device (recording device) can flexibly vary the criteria so as to optimize the reliability and the transfer rate, depending on the nature, type, characteristics, and the degree of importance of the data to be recorded. For instance, a countermeasure for errors may be provided in the application software or file system. That is, error correcting coding may be applied before transmitting the data to the disk device at a predetermined rate. In this case, the defect management at the disk device is not so important, and the capability of continuous real-time recording at a high data transfer rate may be important.

The embodiment described above can meet with these requirements.

An embodiment of procedure followed in setting a defect criteria will be described with reference to Fig. 9. First, the host device sets the defect criteria to be used, according to type or contents of the data to be recorded. Then, a command for setting the criteria is sent from the host device to the disk device (drive). The disk device selects or sets the criteria upon reception of the command accordingly. In the system shown in Fig. 2, the command sent from the host device to the disk device is one for merely specifying selection between the criteria A and B. In the system shown in Fig. 8 in which the defect criteria can be set, the system is so configured that the defect criteria can be set arbitrarily at the host device, and the

command indicates the defect criteria set at the host
device. Details of the command for setting the defect
criteria may be one which will be described later with
reference to Fig. 11, in which the defect criteria control
information can select one among a plurality of criteria
independently, for each of the servo defect, header defect,
and data defect.

The host device then sends a recording command together
with the data to be recorded. Upon reception of the
command, the disk device records data in the specified
sectors, and performs the defect management using the defect
criteria set in the manner described above, and reports the
results of the defect management to the host device. The
host device terminates a series of recording when it
confirms that recording has been completed correctly. If
the recording has been done incorrectly, a predetermined
process (re-writing or informing the user) for dealing with
the incorrectness is carried out.

According to the procedure of Fig. 9, the host device,
which knows the contents of the data to be recorded, sets
the defect criteria finely optimized according to the type
or contents of the data. It is therefore possible to
provide flexibility for obtaining an optimum combination of
reliability and transfer rate according to the intended use
of the data.

Fig. 10 shows another embodiment of a procedure
followed for setting a defect criteria. In this embodiment,
a command which sets a defect criteria and also instructs
data recording is sent. First, the host device determines a
defect criteria to be used in accordance with the type or
contents of the data to be recorded, and then prepares the
data to be recorded. This order may be reversed.   -

Then, the host device sends the recording command which
also sets the defect criteria, to the disk device. In

accordance with the designated defect criteria, the disk
device selects or sets the criteria. The designation of the
setting sent from the host device to the disk device may be
one for specifying selection among a plurality of preset
criteria (such as between the criteria A and B), or one for
setting an arbitrary criteria.

The disk device records the data received together with
the command, on the disk, while performing defect management
in accordance with the defect criteria which has been set as
described above, and informs the host device of the result.
According to this embodiment, it is possible to obtain an
optimum combination of reliability and transfer rate
depending on the intended use of the disk, as in other
embodiments described earlier. Moreover, because the number
of commands transferred is reduced, the overhead is reduced,
and the possibility of the transfer rate becoming lowered is
reduced.

A manner of recording control information representing
the defect criteria designated at the time of data
recording, in every sector on a disk will now be described.
Fig. 11 shows the configuration of a defect criteria control
information. With this configuration, one of four different
criteria can be specified for each of the servo defect, the
header defect and the data defect independently, by using
one byte.

The most-significant bit b7 indicates the mode of
designation of the defect criteria. If the value of bit b7
is "1", the mode designated by other bits of the control
information byte is used, while if the value is "0" the
default criteria which the disk device has is used ignoring
the other bits of the control information byte.

The next bit b6 indicates the range within which the
defect criteria should be applied. If the value of bit b6
is "1", the mode set by other bits in the control

information byte of are applied for each unit of recording, e.g., each sector or block. If the value of bit b6 is "0" the same criteria is to be applied over the entire surface of the disk.

The next two bits (b5 and b4) indicate the criteria applied for the servo defect, among the four criteria. If the combined value of bits b5 and b4 are "11" the tracking error tolerance above which the servo defect is recognized is one-forth the track width Wt. If the combined value is "10" the tolerance is one-sixth the track width Wt. If the combined value is "01" the tolerance is one-eighth the track width Wt. If the combined value is "00" the tolerance is one-tenth the track width Wt.

The next two bits b3 and b2 indicate the defect criteria to be applied for the header defect, among the four criteria. If the combined value of the bits b3 and b2 is "11" the ECC block is found to have a header defect if all four ID's are unreadable at two or more of its sectors. If the combined value is "10" the ECC block is found to have a header defect if three or more ID's are unreadable at two or more of its sectors. If the combined value is "01" the ECC block is found to have a header defect if all four ID's are unreadable at one or more of its sectors. If the combined value is "00" the ECC block is found to have a header defect if three or more ID's are unreadable at one or more of its sectors.

The last two bits b1 and b0 indicate the defect criteria to be applied for the data defect, among the four criteria. If the combined value of the bits b1 and b0 is "11", the ECC block is found to have a data defect if at least 16 of its rows have errors in at least 8 bytes each. If the combined value is "10", the ECC block is found to have a data defect if at least 8 of its rows have errors in at least 8 bytes each. If the combined value is "01", the

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ECC block is found to have a data defect if at least 8 of its rows have errors in at least 4 bytes each. If the combined value "00", the ECC block is found to have a data defect if at least 6 of its rows have errors in at least 4 bytes each.

The above described defect criteria control information can be located in each sector which constitutes a minimum unit of recording. In a DVD-RAM, a one-byte area may be reserved in the control information area located at the beginning of the data area shown in Fig. 4. The criteria may be set for each sector separately. The same defect criteria control information may be set in all the sectors within the same ECC block, or in predetermined sectors, so that the defect criteria control information is repeatedly recorded, and the range within which the same defect criteria should be applied may be made to coincide with the unit of error correction (ECC block).

The provision for enabling setting the finely optimized criteria improves the utility for the user in multimedia applications in which the audio or video data and computer data are intermixed with each other. It should be noted that the defect criteria to be applied to the respective data can be switched at the system (host device) depending on the contents of the data, and it is possible to realize a flexibility for obtaining the optimum combination of the reliability and transfer rate.

It is possible to pre-select a defect criteria to be used in recording on a disk, and record the criteria as defect criteria control information on the disk, before the disk is used. Fig. 12 shows an example of arrangement of control information areas, and a data recording region including user areas and spare areas, and arrangement of defect criteria control information in the control areas. The data recording region is divided into groups, each of

which includes a user area and a spare area. The control
information areas are disposed near the inner and outer
peripheries of the disk, and the same control information is
recorded on the respective control information areas.

In a known example, a defect management method is
recorded in a control information area. In contrast,
according to this embodiment, defect criteria control
information is stored in a control information area. At the
time of starting a disk, the disk device reads the defect
criteria control information to know the defect criteria.
If the defect criteria suitable for the intended use, such
as computer data, audio or video data, or the like is
recorded, the defect determination according to the defect
criteria can be made.

If one bit is provided in the control information area
for recording the defect criteria control information, it is
possible to record two sets of defect criteria, and
selectively use them. For recording three or four sets of
defect criteria, and using them selectively, two bits should
be provided in the control information area. If one byte is
provided in the control information area, it is possible to
select one of the criteria for each of the servo defect,
data defect and header defect, and to specify a combination
of specific defect criteria for the respective types, as
described with reference to Fig. 11.

With such a provision, if the information is recorded
once at the time of initialization of the disk, the defect
criteria can be applied to all the data thereafter recorded
on the disk. It is therefore possible to eliminate to need
to set the defect criteria each time the data is recorded.
Accordingly, the recording can be effected at a high speed,
and in a simple manner.

CLAIMS:

1.   A recording device controller comprising:

means for determining defect detection criteria applied according to the type of data to be recorded; and

means for issuing a command for setting the determined defect detection criteria in a recording device.

2.   A recording device controller comprising:

means for determining defect detection criteria applied according to the type of data to be recorded; and

means for issuing a single command for instructing that the determined defect detection criteria be set in a recording device and that recording of data be carried out.

3.   The controller according to claim 1 or claim 2, wherein said command is of a structure by which the defect detection criteria can be designated independently for a plurality of kinds of criteria items.

4.   A recording device controller comprising:

means for determining information relating to the type of data recorded in accordance with the type of data recorded; and

means for issuing a command for transferring the information relating to the type of data recorded that has been determined to a recording device.

5.   A recording device controller comprising:

means for determining information relating to the type of data recorded in accordance with the type of data recorded; and

means for issuing a single command instructing that the information relating to the type of data recorded that has been determined be transferred to a recording device, and that the recording of the data be carried out.

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6. The controller according to claim 4 or claim 5, wherein the information relating to the type of data recorded is a flag designating a method of defect processing for the data recorded.

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7. A method of managing defects on an optical disk used for recording data, comprising the steps of

determining a criteria for detecting said defects according to the type of data for which defects are to be detected; and

10 detecting said defects using said criteria when data is recorded on or reproduced from said disk.

8. A disk device for accessing data on an optical disk, comprising:

means for determining a criteria for detecting said defects according to

15 the type of data for which defects are to be recorded; and

means for detecting said defects using said criteria when data is recorded on or reproduced from said disk.

9. An optical disk for recording data, comprising an area storing criteria

20 control information specifying criteria to be used for detecting defects for data recorded on or reproduced from the disk.

10. A disk recording and/or reproducing device comprising means for applying one of a plurality of predetermined criteria for recording and/or

25 reproducing data according to the type of data to be recorded and/or reproduced.

3S

CLAIMS:

1.   A disk recording device controller comprising:

means for determining defect detection criteria applied according to
the type of data to be recorded; and

means for issuing a command for setting the determined defect
detection criteria in a recording device.

2.   A disk recording device controller comprising:

means for determining defect detection criteria applied according to
the type of data to be recorded; and

means for issuing a single command for instructing that the
determined defect detection criteria be set in a recording device and that
recording of data be carried out.

3.   The controller according to claim 1 or claim 2, wherein said command
is of a structure by which the defect detection criteria can be designated
independently for a plurality of kinds of criteria items.

4.   A disk recording device controller comprising:

means for determining information relating to the type of data
recorded in accordance with the type of data recorded; and

means for issuing a command for transferring the information relating
to the type of data recorded that has been determined to a recording device to
determine defect detection criteria.

5.   A disk recording device controller comprising:

means for determining information relating to the type of data
recorded in accordance with the type of data recorded; and

means for issuing a single command instructing that the information
relating to the type of data recorded that has been determined be transferred to

a recording device to determine defect detection criteria, and that the recording of the data be carried out.
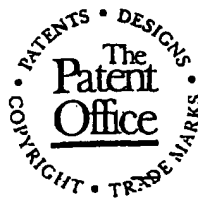
6.   The controller according to claim 4 or claim 5, wherein the information relating to the type of data recorded is a flag designating a method of defect processing for the data recorded.

7.   A method of managing defects on an optical disk used for recording data, comprising the steps of

determining a criteria for detecting said defects according to the type of data for which defects are to be detected; and

detecting said defects using said criteria when data is recorded on or reproduced from said disk.

8.   A disk device for accessing data on an optical disk, comprising:

means for determining a criteria for detecting said defects according to the type of data for which defects are to be recorded; and

means for detecting said defects using said criteria when data is recorded on or reproduced from said disk.

9.   An optical disk for recording data, comprising an area storing criteria control information specifying criteria to be used for detecting defects for data recorded on or reproduced from the disk.

10.   A disk recording and/or reproducing device comprising means for applying one of a plurality of predetermined criteria for recording and/or reproducing data according to the type of data to be recorded and/or reproduced.

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Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

    UK Cl (Ed.S): G5R (RB27, RB33)

    Int Cl (Ed.7): G11B 20/12, 20/18

Other: Online: EPODOC; JAPIO; WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X	US 5237553 (FUKUSHIMA et al) see column 4 lines 19 to 49	9

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
		E	Patent document published on or after, but with priority date earlier than, the filing date of this application.
&	Member of the same patent family		